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ABSTRACT

The hypothesis that variation in accessibility of categorical knowledge affects its use as an organizational device was tested in this experiment using 36 second graders and 36 fifth graders from a middle-class community within San Diego, California. The students memorized each of two lists of words that differed in category representativeness. They received one of three memory instructions: standard free recall, repetition, or categorical processing. Recall performance was about equal for standard vs. repetition, and both were lower than category processing, especially with the highly representative items. Age did not enter this interaction, so it is concluded that at both age levels, accessibility of categorical information influences children's use of it. This suggests multiple types of possible production deficiencies. It appears possible to distinguish between a production deficiency that can be attributed to an initial disposition of the subject and one that can be attributed to the relative accessibility of relevant information. (PN)

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# THE USE OF CATEGORICAL ORGANIZATION: NOT AN ALL-OR-NONE SITUATION

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# The Use of Categorical Organization: Not an All-or-None Situation

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Second and fifth graders memorized each of two lists of words that differed in category representativeness. In addition, they received one of three memory instructions: standard free recall, repetition, or categorical processing. Recall performance was about equal for standard vs repetition, and both were lower than category processing, especially with the highly representative items. Age did not enter this interaction, so it is concluded that at both age levels, the accessibility of categorical information influences children's use of it. This suggests multiple types of possible production deficiencies.

When children and college students are asked to free recall a list of categorizable words, the older subjects consistently show more use of the category structure to organize the material. This tendency seems to account for the related differences in the amount recalled (Moely, 1977). It is assumed that the children have the categorical knowledge necessary to organize the list, but simply do not use that knowledge. Flavell (1971) has characterized this failure as a production deficiency.

In attempting to remove or reduce developmental differences in the amount recalled, one method has been to "prod" the child to use the categorical structure to organize the list. For example, some researchers have attempted to train an organizational strategy explicitly (Moely & Jeffrey, 1974); others have made this procedure more overt by actually

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having the children sort the items (Lange & Jackson, 1974; Worden, 1976). Still others tried to make the categorical organization salient by blocking the items by categories durng presentation (Cole, Frankel, & Sharp, 1971). Each of these procedures increases children's recall performance, and this supports the claim that the children had available knowledge that they were not using.

One question that can be asked, however, is what constitutes "available knowledge?" Clearly, a situation can be imagined in which a person must search long and hard for a piece of previously encoded information before that information is retrieved. Alternately, some information seems to be easily accessible and quickly retrieved. Are not both these pieces of information available? In the above discussion, the issue centered on whether a piece of knowledge was previously encoded or not; that is, whether the child knew that *x* was related to *y* or that *x* was a member of category *y*. Little concern is given to the hypothesis that available knowledge might vary with age and familiarity in terms of accessibility. Even more important is the possibility that highly accessible knowledge will be utilized more readily.

It is generally thought that the strategic use of some knowledge base and the accessibility of the knowledge itself are two separate noninteracting factors. In typical training studies (Rohwer, 1976), removal of performance differences is attempted through instruction and application of certain strategies or knowledge. The instruction seeks to mimic successful mnemonic activity. The underlying assumption is that the child has the relevant knowledge needed to take advantage of the instruction, and prompting the use of that knowledge or strategy should remove the developmental differences in performance. The possibility that differences in the accessibility of relevant knowledge might affect the child's use of such knowledge is not taken into account. One indication that this possibility needs to be taken into account is that training studies are seldom completely successful; when instructions are given, age differences in performance are still obtained (Butterfield, Wambold, & Belmont, 1973).

Within a categorical knowledge structure, it has clearly been shown that all category exemplars are not equally representative of a category. Some exemplars are more prototypical of their related superordinate than others, and this variation seems to affect the accessibility of the information. For example, adults are faster at verifying that an item is a member of a category if the item is a highly prototypical member (Rosch, 1973). They also tend to list highly prototypical items more often than less prototypical items when asked to generate exemplars from given superordinate categories (Mervis, Catlin, & Rosch, 1976). While this same pattern of free generation data is also obtained with children (Nelson, 1974; Posnansky, 1978), perusal of these norms indicates that the overall

level of agreement on "good" members of categories tends to increase with age.

It has been suggested that the organization or structure of knowledge might vary depending on the degree of the familiarity of the concepts within a domain (Chi & Koeske, 1983). Theories of semantic memory have suggested that knowledge is stored in terms of an associative net (Collins & Quillian, 1969). Concepts are conceptualized as being stored as the nodes of the net while relations between concepts serve as associative links. One property of associative links is that they specify the relations among concepts, such as "belongs to the category of" (the ISA link) or "has a certain property" (the HAS link). A second property is that associative links can vary in strength; some concepts are strongly associated with each other, whereas other concepts are weakly associated.

Chi and Koeske (1983) suggest that very familiar concepts might be conceptualized as forming a tightly structured, highly interrelated organization, while less familiar concepts are less integrated into the organizational structure and have weaker associative links. These authors attempted to represent a child's knowledge of the category of dinosaurs. The well-known dinosaur seemed to form a more tightly structured unit, containing more and stronger associative pathways than did the representation of the lesser known dinosaurs. In much the same way, the organization of knowledge for highly prototypical exemplars might be different from less prototypical members. The highly prototypical items might be conceptualized as forming a tightly structured, highly interrelated organization, while less prototypical exemplars are less integrated into the categorical structure and have weaker associative links among the items.

Variation in accessibility of categorical knowledge might affect how easily the categorical structure could be used as an organizational device. Haynes and Kulhavey (1976) showed that children were better able to memorize a list when highly typical category exemplars are presented than when a list of low typical exemplars are presented when the children were instructed about the categorical nature of the list. In addition, Bjorklund and Thompson (1983) showed that children were better able to recall lists of highly prototypical exemplars when given the superordinate as a cue than a list of less prototypical exemplars. However, in both these experiments, the authors failed to include a condition where no retrieval cues or instructions were provided. Thus, it is not known whether subjects were better able to recall the highly prototypical list than the low prototypical because they were better able to use the category information as retrieval cues or because the highly prototypical items were more meaningful to the children than the low prototypical items (Richman, Nida, & Pittman, 1976).

## USE OF CATEGORICAL ORGANIZATION

The hypothesis that variation in accessibility of categorical knowledge affects its use as an organizational device was tested in this experiment using subjects from grades 2 and 5 crossed with two experimental factors. First, two word lists were constructed where exemplars differed in their representativeness to their respective categories. This yielded a high and a medium representative list. Second, there were three conditions which varied the likelihood that the category structure would be discovered. In the *standard* condition, subjects were simply told that they were to see a list of words and then to study the items in order to remember as many as possible later on. In the *category* condition, the subjects were informed of the categorical nature of the list and were presented the list items blocked by categories. They were also told that if they tried to group the items by categories they would be able to remember more items later on. In the *repetition* condition, subjects were instructed to repeat each item aloud, by itself, over and over again until the next item was presented. It was thought this intervening task would interfere with categorization (Ornstein, Naus, & Stone, 1977), and thus it served as a control to ascertain whether the subjects in the standard condition were trying to categorize the items.

On the basis of past experiments with adults (Greenberg & Bjorklund, 1981; Keller & Kellas, 1978; Rabinowitz, 1982), and children (Bjorklund & Thompson, 1983; Haynes & Kulhavey, 1976), it was predicted that subjects in all conditions would recall more items from the high representative list than from the medium list. Also, since subjects in this age range normally do not use the category structure as an aid for memorization (Moely, 1977), it was predicted that the subjects in the repetition and standard conditions would not differ significantly in the amount recalled, and that subjects in the category condition would recall significantly more than those in the standard repetition conditions. However, assuming category information varies with its accessibility, it was further predicted that subjects in the category condition would benefit more with the high list than with the medium. A final prediction is that the memory condition by list interaction would be bigger for the 5th graders than for the 2nd graders. This last prediction was made on the assumption that the categorical information also becomes more accessible with age.

### METHOD

#### *Subjects*

There were 36 second graders and 36 fifth graders sampled from a middle-class community within San Diego, California. The mean ages for the second and fifth graders, respectively, were 7 years, 7 months (range = 7 years, zero months to 8 years, 3 months) and 10 years, 7 months (range = 9 years, 7 months to 11 years, 3 months).

*Materials and Procedure*

The stimuli consisted of two lists (high and medium) of 24 common nouns chosen from Posnansky's (1973, 1978)[1] free generation category norms. Each list contained four items from the following six categories: Animals, Vehicles, Body Parts, Furniture, Clothing, and Fruits. The items on each list are presented in Table 1.

The high list consisted of the items that were most frequently generated by second graders when a category label was given. The medium list consisted of items taken from the middle of the generation norms for each category. The range of the number of times items were generated for these six categories varied from 1 to 74 (there were 81 second graders tested). The average number of times the items on the high list were generated equaled 43.3 ($SD$ = 14.8). The average number of times the

[1] The stimuli were actually selected from the 1973 report. In the 1978 publication all items that were mentioned by only one subject were not provided. Consequently, the items berry, belt, and vest are not listed in the 1978 norms.

TABLE 1
STIMULI

| Category representativeness | High | Medium |
|---|---|---|
| Animals | Horse | Rabbit |
| | Pig | Sheep |
| | Cat | Goat |
| | Dog | Fox |
| Body parts | Hand | Back |
| | Arm | Neck |
| | Head | Knee |
| | Leg | Toe |
| Clothing | Skirt | Scarf |
| | Dress | Belt |
| | Pants | Vest |
| | Socks | Sweater |
| Fruits | Grape | Berry |
| | Orange | Lemon |
| | Apple | Plum |
| | Banana | Tomato |
| Furniture | Chair | Stool |
| | Table | Bench |
| | Couch | Lamp |
| | Bed | Dresser |
| Vehicles | Car | Boat |
| | Bus | Plane |
| | Truck | Wagon |
| | Bike | Tractor |

items on the medium list were generated was 5.9 ($SD$ = 3.7). This manipulation based on free generation norms was considered to be similar to a prototypicality manipulation in that the children and adults are both more likely to list prototypical examplars given superordinate categories (Mervis et al., 1976; Posnansky, 1978). In fact, when compared to the typicality judgments of adults in the Uyeda and Mandler (1980) norms only two items in the high list (pig and socks) were given lower ratings than items in the medium list. In comparison with the Rosch (1975) adult norms, four items in the high list (socks, grape, bed, and bike) were given lower ratings than items in the medium list[2]. Thus, there seems to be high agreement between the second graders' category generation norms and adults' typicality norms.

Subjects were randomly assigned to one of three memory instruction conditions (standard, repetition, or category). All subjects were instructed that they were to be shown a list of words and that they were to study the items so that after they had seen them they would be able to recall as many as possible. They were also told that they would be able to recall the items in any order.

Subjects in the repetition and category conditions were told that they were to try to study the items in a specific way. Subjects in the repetition condition were instructed to study each item in isolation from all the other items. They were to do this by repeating each item over and over again, aloud, until the next item was presented. Subjects in the category condition were informed of the categorical nature of the list and were told that they should try to group all the items from the same category together. Subjects in both conditions were instructed that it was very important to study the items in the way specified and that they should not try to use other strategies.

Subjects were presented both lists (high and medium) with list order counterbalanced across subjects within grade level. After the first list was presented, to remove any recency effects, subjects were given additional instructions; they were told that they could recall the items in any order and were also instructed that they were to recall the items out loud. After the first recall, additional instructions were given; subjects were once again reminded of how to rehearse the materials. The second list was then presented followed by additional instructions, and then recall.

Subjects in the repetition and standard memory conditions were presented with one of two random orderings of the two lists. The random orderings were generated with the constraint that one item from each category must be presented before an additional item from any category was

[2] Only four of the six categories used in this experiment were represented in the Rosch (1975) norms.

presented. Also, no two items from the same category could be presented consecutively. To make the categorical structure as salient as possible for the young children, the lists in the category condition were presented blocked by categories. Thus, to maximize the likelihood of discovery of the categorical organization in this condition, category instructions and category blocking were confounded. Two orderings of this presentation list were generated, with the ordering of categories and order of the exemplars within a category randomly selected.

All subjects were tested by one of two experimenters in individual sessions lasting approximately 20 minutes. Each experimenter ran half the subjects in each condition. After the initial instructions and prior to the presentation of the first list, a practice list was presented. The list was composed of four items; two items from two categories (Dwellings: house and castle, Musical Instruments: piano and guitar). Subjects in the standard and the repetition conditions were presented the practice items in a random order with the constraints mentioned above. Subjects in the category condition were presented the items in a blocked fashion. The stimulus materials were presented both orally and visually. Both lists were recorded on a cassette tape at a presentation rate of five seconds per item, and the experimenter presented each item, as a printed word, in the center of a 12.7 cm × 17.8 cm index card. Each subject was given three minutes to recall the 24 items. The recall was written down by the experimenter in addition to being tape recorded.

## RESULTS

### *Recall*

Percentage of items remembered were analyzed by analysis of variance comparing memory instructions (repetition, standard, category), list (high, medium), grade (2 and 5), and order of presentation (high–medium, medium–high). The list factor was a within-subjects factor, and the others were between-subjects factors. In the results discussed below, there were no significant main effects or interactions involving the factor of order of presentation. For this reason, this factor will not be discussed further. The relevant means are shown in Table 2.

Fifth graders recalled significantly more items ($M$ = .38) than second graders ($M$ = .28), $F(1, 60) = 27.82$, $p < .001$. Subjects also recalled more items from the high list ($M$ = .40) than from the medium list ($M$ = .26), $F(1, 60) = 70.53$, $p < .001$. In addition, there was a significant main effect of memory conditions, $F(2, 60) = 33.73$, $p < .001$. Scheffe tests indicated that recall in the category condition ($M$ = .44) was significantly better than that in both the standard ($M$ = .28) and repetition ($M$ = .27) conditions, both $p$'s < .05, and that performance in the standard condition was not significantly better than that in the repetition

TABLE 2

PERCENTAGE RECALLED, CLUSTERING, AND NUMBER OF ITEMS RECALLED PER CATEGORY AS A FUNCTION OF GRADE, MEMORY CONDITION, AND LIST

| Grade | List | Memory condition | | |
|---|---|---|---|---|
| | | Repetition | Standard | Category |
| Percentage recalled | | | | |
| Second grade | | | | |
| | High | .26 | .28 | .48 |
| | Medium | .18 | .19 | .29 |
| Fifth grade | | | | |
| | High | .36 | .40 | .61 |
| | Medium | .28 | .25 | .39 |
| $MS_e$ (between) = .0132, $MS_e$ (within) = .0094 | | | | |
| Clustering (RR) | | | | |
| Second grade | | | | |
| | High | .22 | .21 | .54 |
| | Medium | .15 | .03 | .41 |
| Fifth grade | | | | |
| | High | .23 | .22 | .57 |
| | Medium | .15 | .13 | .38 |
| $MS_e$ (between) = .0290, $MS_e$ (within) = .0232 | | | | |
| Number of items recalled per category (first entry only) | | | | |
| Second grade | | | | |
| | High | 1.3 | 1.3 | 2.6 |
| | Medium | 1.2 | 1.0 | 1.8 |
| Fifth grade | | | | |
| | High | 1.5 | 1.4 | 2.7 |
| | Medium | 1.2 | 1.1 | 1.8 |
| $MS_e$ (between) = .2262, $MS_e$ (within) = .1621 | | | | |

condition, $p$, $> .05$. However, this finding must be qualified in that the interaction between list and memory conditions was significant, $F(2, 60) = 5.39$, $p < .01$. Post hoc Scheffè tests indicated that differences in recall between category and standard conditions were greater with the high list ($D = .21$) than with the medium ($D = .12$), $p < .05$. A similar interaction was observed in the comparison of the difference in recall between the category and repetition groups; the difference with the high list was .24, the difference with the medium list was .11, $p = .05$. There was no significant interaction between the repetition and standard groups on recall of the high and medium lists. Thus, the subjects were better able to take advantage of the category structure to improve recall with the high list than with the medium list.

This interaction between list and memory condition can also be interpreted in a second way. Initial examination of this interaction revealed that recall was significantly greater on the high list than on the medium

for each condition, $t$'s(60) > 2.86, $p$'s < .05. However, subsequent Scheffè tests indicated that subjects in the category condition demonstrated a significantly greater increase in recall on the high relative to the medium list ($D$ = .21) than subjects in the standard ($D$ = .12) or repetition ($D$ = .08) conditions, the latter two not differing from one another. Thus, the difference in the amount recalled from the high and medium lists was greatly attenuated in the category condition. None of the other interactions was significant.

*Clustering*

Clustering according to the categorical organization was measured using the ratio of repetition (RR) (Cohen, Sakoda, & Bousfield, 1954). This measure varies from 0 in the case of no clustering to .78 in the case of perfect clustering with perfect recall. The relevant means for this analysis are shown in Table 2.

An analysis of variance indicated that subjects showed significantly more clustering in their recall of the high list ($M$ = .33) than in their recall of the medium list ($M$ = .21), $F(1, 60) = 24.58$, $p < .001$. In addition, a significant main effect for memory condition was obtained, $F(2, 60) = 53.31$, $p < .001$. Subsequent Scheffè tests indicated that clustering in the repetition condition ($M$ = .19) was not significantly different from the amount found in the standard condition ($M$ = .15), $p > .05$. However, clustering in the category condition was significantly greater ($M$ = .48) than that found in either the standard or repetition conditions, both $p$'s < .001. There were no significant differences found in clustering between grades, nor were any of the interactions between any of the factors significant.[3] Further analyses indicate that while clustering in the standard and repetition conditions was not significantly different from chance level of clustering (.13), clustering in the category condition was [$t(35) = 4.0$, $p < .001$].[4]

Although a significant interaction between list and memory instructions for percent recall was obtained between the standard and category conditions, the corresponding interaction for clustering was not significant. A problem arises in that the greater recall in the category condition on the high list was predicted to come about because of an increased use of the categorical structure. Although subjects in the category group did tend to cluster their recall more than subjects in the standard group with the high list, this effect was also found to an equivalent degree with the medium list.

[3] Analysis of clustering using the relative ratio of repetition (RRR) measure (Bousfield & Bousfield, 1966) yielded an identical pattern of results.

[4] Chance level of clustering was determined by the formula $(E - 1)/N - 1)$ (Murphy, 1979), where $E$ is equal to the number of exemplars in each category and $N$ is equal to the number of items in the to-be-remembered list.

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An analysis of the mean number of items recalled per category (only upon the first entry into a category) was conducted to further see whether the subjects used the category structure better with the high list than with the medium list. The relevant means for this analysis are also presented in Table 2. The analyses of variance indicated that subjects recalled significantly more items upon first entry into a category with the high list ($M$ = 1.78) than with the medium list ($M$ = 1.37), $F(1, 60) = 37.71$, $p < .001$. In addition, there was a significant main effect of conditions with subjects in the repetition condition averaging 1.31 items, subjects in the standard condition 1.19, and subjects in the category condition, 2.22, $F(2, 60) = 66.86$, $p < .001$. Subsequent Scheffè tests indicated that the means for the repetition and standard conditions were not significantly different, $p > .05$, but the mean for the category group was significantly higher than that of both the standard and repetition groups, both $p$'s $< .05$. There was also a significant interaction between list and condition, $F(2, 60) = 10.25$, $p < .001$. A Scheffè test indicated that the increase in the average number of items from a category recalled upon first entry between the standard and category conditions was significantly greater for the high list (standard, high = 1.3 items, category, high = 2.6 items), than for the medium list (standard, medium = 1.1, category, medium = 1.8), $p < .05$. A similar interaction was obtained for the comparison of the repetition and category groups, $p < .05$. However, the comparison between the standard and repetition groups was not significant, $p > .05$. Given the blocked presentation of the categorical list, there is reason to suspect that if subjects tended to recall the last items in the list first, recency effects might differently aid subjects on this measure in the category condition compared to subjects in the standard and repetition conditions. However, additional instructions were given after each list was presented and prior to recall to eliminate such effects. In addition, there is no a priori reason to suspect that simply recalling the last items first should aid recall of the high list more than the recall of the medium list. None of the other main effects or interactions was significant. Thus, from this analysis, it appears that subjects made better use of the category structure with the high list than with the medium.

## DISCUSSION

The results from this experiment clearly replicate previous findings showing that children will not use a categorical organization as an aid for memorization unless they are explicitly instructed to do so or unless that organization is made extremely salient. Subjects in the standard condition did not recall significantly more items than subjects who were instructed to use the repetition strategy. Given that use of the repetition strategy has been shown to decrease recall performance of subjects who would not normally use such a strategy (Ornstein et al., 1977; Rabinowitz,

1982), it might be suggested that the subjects in the standard condition were using a similar strategy. In addition, subjects in the category condition recalled significantly more items than subjects in both the repetition and standard free recall conditions. Thus, it appears that even though the children had the categorical knowledge necessary to take advantage of this structure within the list, they did not do so unless that structure was made very obvious.

While subjects in the category condition recalled significantly more items than subjects in the standard condition, the advantage of categorical organization varied depending upon which list the subjects studied. Improvement was greater with the high list than with the medium. This improvement can be attributed to the greater use of the category structure with the high list than with the medium. Subjects in the category condition recalled more items from a category at one time than subjects in the standard condition, and this effect was larger for the high list than for the medium list. However, this interaction was not mirrored in the analysis of clustering scores.

It was also predicted that this memory condition × list interaction might be bigger for the fifth graders than for the second graders because the categorical information might become more accessible with age. This prediction was not supported by the results of this experiment. However, in this experiment, the word lists were constructed solely on the basis of second graders' category production norms. The decision to use only one set of lists for both age groups might have caused the fifth graders' materials to be misscaled, and this might in turn have lowered their recall. By controlling for accessibility across age groups, i.e., constructing lists to match the knowledge base separately for each age group, the interaction with age might have been obtained.

Thus, it appears that the ability to use the category structure of the stimulus materials does depend on the representativeness of the exemplars of their related superordinates. Highly prototypical exemplars might be conceptualized as forming a tightly structured organization with strong associative links connecting the exemplars to each other and to the related superordinate. This allows the categorical relations among the items to be very accessible. Less prototypical exemplars, however, might be considered to be less integrated into the categorical structure and to have weaker associative links to categorical relations and to other exemplars from that category. This should make such information less accessible.

This finding suggests that it may be difficult to remove developmental differences in performance solely through the training of specific strategies, as is attempted in the training study. Even though in this study children of both grades were able to take advantage of the categorical organization equally, children are thought to be less familiar with most concepts and their relations than adults. Thus, children may be at a disadvantage in

two ways as compared to adults. First, they are unlikely to have as much knowledge as adults concerning strategic processing, and second, it may be harder for them to take advantage of a given strategy or organization. Therefore, quite a bit of training in the use of a strategy may be needed before a child becomes as facile at taking advantage of certain information as an adult.

In addition, the results from this experiment can be used to help distinguish between various types of production deficiencies. There are a number of reasons why a production deficiency might be observed. First, a subject may not use available knowledge because of ignorance of the various memorization strategies which would capitalize upon that knowledge (Flavell & Wellman, 1977). Second, production deficiencies can come about because children prefer to attend to the sound of words and use these as a basis for relating items rather than semantic attributes (Bach & Underwood, 1970; Tenney, 1975). Another suggestion is that children prefer to organize material thematically as opposed to taxonomically (Ceci & Howe, 1978; Denney & Ziobrowski, 1972; Worden, 1976). I will label all the above hypotheses as predisposition hypotheses because all of them imply that the subjects come to the task with a certain orientation.

Alternately, a child might exhibit a production deficiency not because of any predispositon to use or not use available knowledge, but rather because certain knowledge may be more or less accessible. The results of this experiment indicate that the use of the organization depended upon how representative the exemplars were to their related superordinates. A related possibility is that what information gets discovered and thus what information is thought to be important is dependent upon the accessibility of the information. There is no reason to expect that a child would make use of a categorical organization if that organization were not very accessible.

Thus, we can distinguish between a production deficiency that can be attributed to an initial disposition of the subject and one that can be attributed to the relative accessibility of relevant information. It should be pointed out, however, that many of the initial disposition explanations can also be accounted for by variation in accessibility. For example, young children might prefer to use a thematic organization rather than a taxonomic organization because the relations inherent in the thematic are more accessible than those in the taxonomic. This distinction, then, is whether children "prefer" to use one organization or strategy over another as a predisposition or, rather, the organization or strategy they use is dependent upon the accessibility of the relevant knowledge.

Clearly further research needs to be conducted on how the use of a given organization or a given strategy depends upon the organization of the knowledge base *and* the accessibility of that information. It is not

simply a matter of whether people organize information in a certain way or whether a bit of information has previously been encoded, but rather how accessible that organization or information is. Accessibility of information might affect not only how well a given organizational device might be used, but also, how much, and what information, might become "automatically" activated (Collins & Loftus, 1975). Variations in accessibility of information might be one of the more important determiners of developmental and individual differences in performance.

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